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1990–91 SURVEY OF PHYSICS AND ASTRONOMY BACHELOR'S DEGREE RECIPIENTS

An expected reaction from new college graduates to the current economic recession was reflected in the shift toward graduate studies and away from immediate employment. Our annual survey of physics and astronomy bachelors continues to examine in detail the postbaccalaureate plans of the graduates and compares their plans with those reported by the members of earlier classes. This report is based on the information contributed by the graduates in the class of 1991 and its highlights are:

- The class of 1991 shows a shift from civilian employment to physics/astronomy graduate study.
- One-fifth of the employment-oriented physics bachelors had not secured any positions shortly after graduation.
- Employed physics bachelors recorded a shift from research, development and design to nonphysics professional work.

The three broad categories of postbaccalaureate plans, graduate study, employment, and no immediate plans, are subdivided into five groups and presented in **Table I**. For example, the potential graduate students are divided according to subject of graduate study. Those who remained in physics, astronomy or a cross-disciplinary area were separated from those whose interests may have ranged anywhere from a science-related discipline to a career in business or the humanities; the latter group is listed under the heading of "other graduate study." The employment group is also divided into two subgroups because the experiences of graduates who need to deal with the economic pressures of a changing job market are very different from those for whom the military service has commissions lined up or offers for additional specialized training. The fifth group of bachelors, though small, consists of graduates who had no specific plans upon receiving their bachelor's degrees; they generally comprise between two and four percent. **Table I** compares the class of 1991 with three earlier classes and lists the total number of physics bachelors for each of those years in its last row. Thus, for the most recent year, we can identify a three percentage-point shift toward graduate study in physics or astronomy and away from civilian employment.

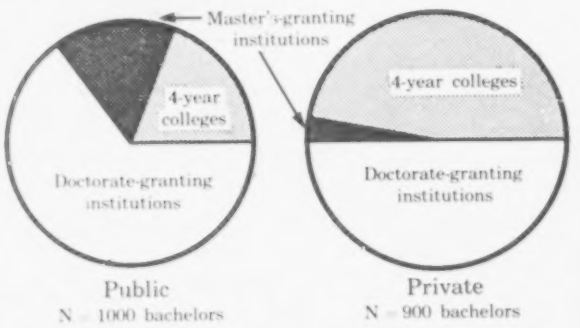
Table I. Postbaccalaureate plans of selected graduating classes of physics bachelors, 1980 to 1991.

Postbaccalaureate plans	1979–80	1984–85	1989–90	1990–91
Physics/Astronomy graduate study*	32%	31%	34%	37%
Other graduate study	22	19	19	20
Civilian employment	38	43	38	35
Military service	5	5	5	4
Undecided	3	2	4	4
Total number of physics bachelor's degrees	4440	5188	5111	5145

**Earlier versions of this table included astronomy and cross-disciplinary areas of physics under "Other graduate study."*

The recent increase in physics bachelors who intend to pursue graduate studies in that discipline focused attention on the baccalaureate sources of those potential graduate students. A well-documented fact is that the doctorate-granting universities constitute the major suppliers of graduate physics students. However, particularly among the private institutions, the four-year colleges also play a major role, as illustrated in **Figure I**. The two pie-diagrams separate the public from the private institutions and subsequently divide each group on the basis of highest physics degree granted.

Figure I. Public and private institutions as sources of graduate physics/astronomy students, 1991.



Member Societies The American Physical Society • Optical Society of America • Acoustical Society of America • The Society of Rheology • American Association of Physics Teachers American Crystallographic Association • American Astronomical Society • American Association of Physicists in Medicine • American Vacuum Society • American Geophysical Union

Table II. Characteristics of new physics bachelors, 1990–91.

Characteristics		Postbaccalaureate plans: Graduate study: Physics/ Astronomy	Graduate study: Other	Employment	Undecided	Total
Initial interest in physics	Curiosity about nature	24%	24%	29%	31%	26%
	Its presentation in high school	18	24	20	20	20
	Its presentation in college	12	10	12	7	11
	A subfield of physics	13	10	11	19	12
Sex	Female	16%	17%	17%	21%	17%
	Male	84	83	83	79	83
Citizenship	U.S.	92%	92%	97%	94%	94%
	Foreign	8	8	3	6	6
Age	21 or younger	10%	8%	4%	4%	7%
	22	47	50	35	36	42
	23	19	21	22	20	21
	24–27	16	13	23	28	19
	28 or older	8	8	16	12	11
Minority groups	U.S. blacks	2%	3%	2%	2%	2%
	U.S. Hispanics	1	2	2	1	2
	U.S. Asians	5	6	4	7	5
	Foreign minorities	5	6	2	4	4
Transfer students from 2-yr institution		9%	5%	17%	12%	11%
Type of degree	Bachelor of science	75%	64%	73%	77%	72%
	Bachelor of arts	25	36	27	23	28
Total number of bachelors		1888	998	2047	212	5145
% distribution		37%	19%	40%	4%	100%
Number of respondents		1003	530	1085	112	2730

When selecting characteristics of new physics bachelors for inclusion in **Table II**, we examine the extent to which they vary with respect to the postbaccalaureate plans. The first of the seven characteristics listed explores the factors that prompted the graduate's interest in physics. Space limitations allowed us to present only the four most popular answers which are led by how the graduate's curiosity about nature attracted him or her to the subject matter physics deals with. Into second and third place fell expressions of praise for the way physics was presented in high school and college respectively. In fourth place (with 12% of the responses) were students who named a specific subfield of physics such as astronomy or space studies.

The background characteristics of sex, citizenship, age and minority groups presented each year in **Table II**, show little change from earlier years. Included in **Table II** this year is the characteristic that an average of 11% of the physics bachelors started their education at a junior college; however, subgroups of those bachelors by postbaccalaureate plan, produce percentages that range from 5% to 17%. The last characteristic, showing what proportion of the bachelors were granted arts degrees, is not always related to the number of credit-hours of physics required to complete that major, but rather to whether or not the physics major is offered by a liberal arts college of a given university.

Table III. A comparison between men and women among the 1990–91 physics bachelors and their high school physics backgrounds.

Type of high school physics		Women	Men	Total N	Total %
PSSC*		5%	4%	120	4%
Project physics		2	1	40	2
AP physics		20	21	560	21
General physics		59	62	1641	61
None		14	12	318	12
Total respondents	%	100%	100%		100%
	N	453	2226	2679	

**PSSC = Physical Science Study Committee.*

Table IV. Postbaccalaureate plans of U.S. and foreign minorities among the responding physics bachelors of the class of 1991.

	Postbaccalaureate plans				
	Graduate study			Total	
Minorities	Physics/ Astronomy	Other	Empl.	%	N
Native American Indians	–	20%	80%	100%	10
U.S. blacks	33%	26	41	100	56
U.S. Hispanics	42	20	38	100	56
U.S. Asians	39	26	35	100	133
Foreign minorities	50%	27%	23%	100%	116
All respondents	37%	19%	44%	100%	2730

As new high school physics courses are being developed, the enrollment in traditional courses such as Physical Science Study Committee (PSSC) continues to decline. Advanced Placement Physics, on the other hand, increased its enrollment by 7 percentage-points since 1987. **Table III** compares the proportions of men and women who began their physics training in high school and shows that 12% of the physics bachelors were not introduced to physics until they reached college.

At the undergraduate level both U.S. and foreign minorities comprise very small percentages, hence the differences in the distribution of their postbaccalaureate plans, unless presented separately, tend to be obscured. Physics bachelors in the class of 1991 included 255 graduates who identified themselves as members of U.S. minority groups. Their postbaccalaureate choices are presented in **Table IV** which compares them with those of 116 members of foreign minorities as well as with all respondents to this survey. A notable difference from earlier years are the career choices of U.S. blacks which are no longer skewed toward employment.

Table V offers additional details by comparing four characteristics of the larger U.S. minority groups with their foreign counterparts. For example, women comprise 15% of the U.S. minorities compared with 22% of the foreign physics bachelors. The fastest growing minority group is that of U.S. Hispanics.

Table V. Selected characteristics of minority physics bachelors, 1991.

		Minority groups								
		Black		Native American	Hispanic		Oriental		Other Asian	
		U.S.	Foreign	Indian	U.S.	Foreign	U.S.	Foreign	U.S.	Foreign
	Total	56	5	10	56	6	101	67	32	38
Sex	Female	11	1	1	3	–	18	17	6	7
	Male	45	4	9	53	6	83	50	26	31
Age	21 or younger	3	1	–	1	–	13	6	4	8
	22	18	2	3	16	2	42	17	17	5
	23	12	–	1	10	–	22	26	4	8
	24	6	1	–	8	–	11	7	1	1
	25–27	12	–	1	9	3	8	9	3	12
	28 or older	5	1	5	12	1	5	2	3	4
Region* of bach's inst.	Northeast	8	1	1	8	1	25	15	13	6
	Southeast	26	1	1	6	1	9	9	1	9
	Central & Mountain	18	2	5	21	1	25	25	9	13
	Pacific	4	1	3	21	3	42	18	9	10
Type of bach's inst.	PhD-granting	22	1	5	33	4	74	43	24	17
	MS-granting	2	1	–	10	1	7	7	2	3
	BS/BA-granting	32	3	5	13	1	20	17	6	18
	Public	29	4	6	45	4	49	43	15	24
	Private	27	1	4	11	2	52	24	17	14

**Regions: Northeast = New England, Middle Atlantic; Southeast = South Atlantic, East South Central; Central = East North Central, West North Central, West South Central.*

Table VI. Sources of anticipated support for first-year graduate study*, 1989 to 1991.

Sources of support		Students planning: Physics/Astronomy graduate study** 1989	1990	1991	Other graduate study 1989	1990	1991
Teaching assistantship		48%	45%	44%	15%	15%	13%
Research assistantship		12	14	13	16	15	14
Fellowship		18	21	21	17	16	18
Family, savings, loan		4	4	5	27	30	31
Part-time employment		4	6	6	16	17	16
Other		1	1	1	2	1	2
Multiple	TA/RA	4	4	5	3	3	3
	TA/Fellowship	6	4	3	2	1	1
	TA/Family, savings, loan	3	1	2	2	2	2
		100%	100%	100%	100%	100%	100%
Graduate study status	full-time	93%	95%	95%	82%	85%	88%
	part-time	7	5	5	18	15	12
Total number of full-time students		1725	1762	1888	940	966	998

**The information was reported for September of each academic year.*

***Earlier versions of this table included astronomy and cross-disciplinary areas of physics under "Other graduate study."*

Amid the current economic slump, available sources of support for graduate studies take on added importance. **Table VI** links subject of graduate study to five sources of support as it compares the physics bachelors who remain in their discipline with those who change to a different subject of study. The typical source of support for a first-year graduate student is a teaching assistantship. By comparing the two groups of physics bachelors who applied to graduate schools, **Table VI** illustrates a significant benefit for remaining in physics, astronomy or a cross-disciplinary area of those sciences; almost half of that group accepted teaching assistantships. By contrast, only 14% to 16% of the group that entered "other graduate study" was assured of a similar type of support. Another major difference comes to light when we compare the proportion of bachelors in each group that needs to resort to personal funds or seek part-time employment off campus; only an approximate 10% of the potential physicists reported these sources of support in contrast to almost half of the nonphysics graduate students.

One source of support conspicuously omitted from the listing in **Table VI** is full-time employment. In the class of 1991 an estimated 200 physics bachelors who had accepted full-time employment pursued graduate studies on a part-time basis and are presented in the lower portion of this table.

Despite the shift toward graduate study, a large proportion (40%) of the physics bachelors in the class of 1991 opted for immediate employment; hence an analysis of the demand for that group is an important part of this survey. One way of accomplishing that is to ask each employment-oriented graduate for the number of job offers he or she received. **Table VII** presents a scale of no offers, one offer and multiple offers for the most recent three years and adds 1985, 1980, and 1975 for purposes of comparison. The first category, "zero job offers," may require some clarification so as not to mistake it for a general unemployment rate; it refers to the period immediately after graduation when many bachelors may not yet have allotted time to explore the job market. However, a five percentage-point increase in one year undoubtedly points to a lower demand for those graduates. The survey also found a decline in the proportion of bachelors who reported multiple employment offers to choose from.

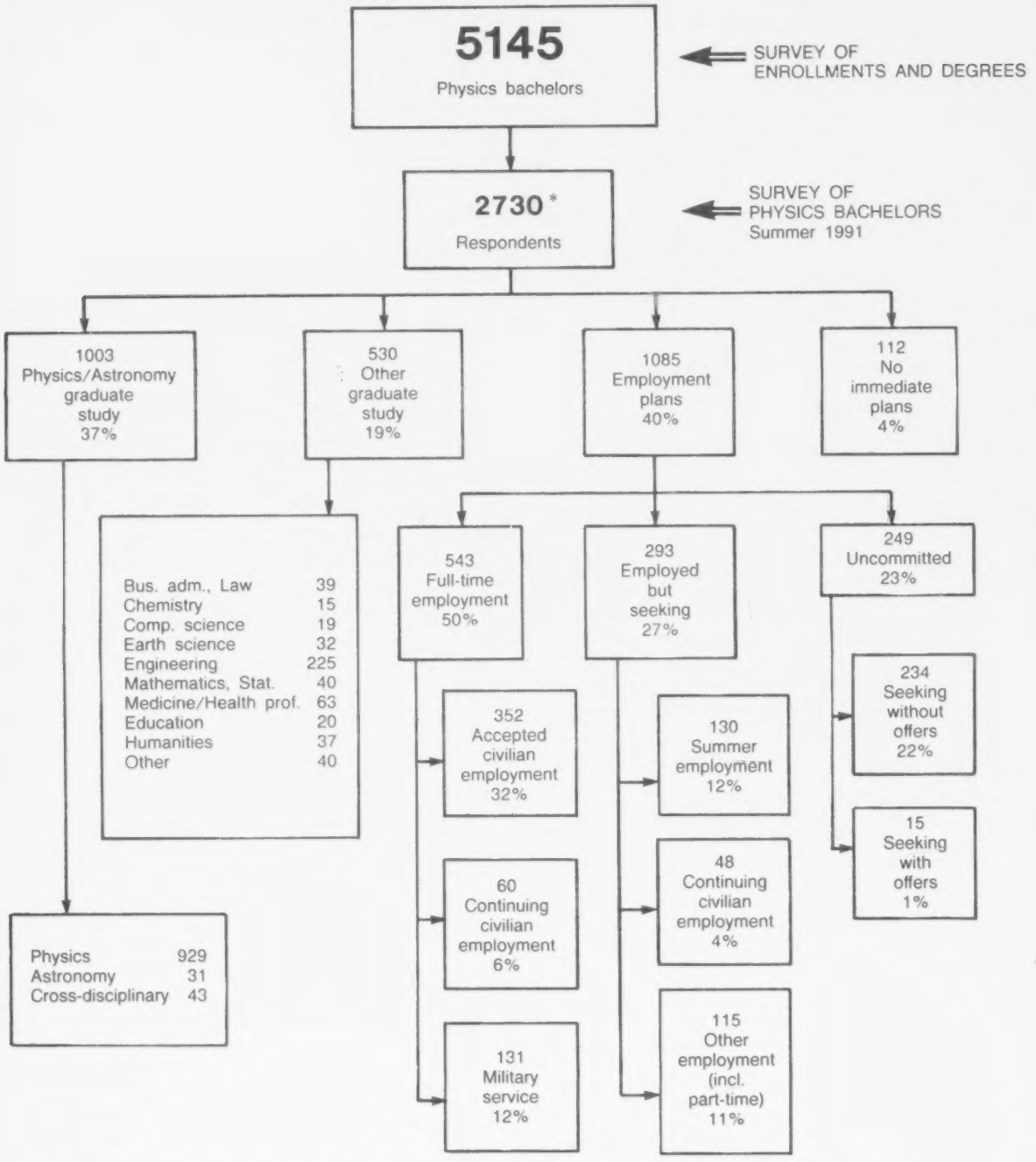
Notwithstanding the earlier references to the shift away from immediate employment, almost 1100 new physics bachelors contributed accounts of their search for initial employment. Their descriptions fall into three groups on which we elaborate in **Figure II**. The largest group, comprising 50%, are the physics bachelors who reported stable full-time employment. The second group described itself as "employed and seeking" because the positions they held either lacked permanence or were holdovers from their student days. The members of the remaining group were still actively seeking employment when they responded to this survey. **Figure II** also elaborates on the postbaccalaureate plans of the potential graduate students by listing the subjects of study they chose.

Table VII. Changes in employment outlook for new physics bachelors, 1975 to 1991.

Number of job offers at graduation	Summer 1975	Summer 1980	Summer 1985	Summer 1989	Summer 1990	Summer 1991
0	17%	10%	14%	16%	17%	22%
1*	56	50	59	68	68	67
2 or more	27	40	27	16	15	11

**Bachelors who enter the military are included here.*

Figure II. Postbaccalaureate plans of physics bachelors of the class of 1991.



**Includes astronomy bachelors from Figure III who reported a double major with physics.*

Table VIII. Initial U.S. or foreign employment of physics bachelors, 1980 to 1991.

Type of employer*		Percentage of employed bachelors				
		1980 -81	1984 -85	1988 -89	1989 -90	1990 -91
Industry	manufacture	40%	33%	29%	28%	21%
	service	22	18	19	18	21
High school		2	5	5	8	9
College or university		4	4	5	5	7
Government	civilian	7	14	12	14	12
	military	21	23	27	25	27
Other		4	3	3	2	3
Total		100%	100%	100%	100%	100%

**Redefinitions of categories make the data in this table not directly comparable to those in earlier versions.*

As the technical manufacturing industry offers fewer opportunities to new graduates, we are observing a gradual shift toward employment in a variety of service industries some of which require technical training. **Table VIII** lists the major types of employers chosen by the new physics bachelors of the three most recent graduating classes and compares this trend with comparable data from the early and mid 1980s thereby contrasting the 2:1 ratio of manufacturing versus service industrial positions a decade ago, with the 1:1 ratio reported by the 1991 graduates. Until the current sluggish economy picks up again, we can expect to see further increases among the bachelors who go into high school teaching or find employment with the government.

By anticipating an expanding service industry to provide initial employment for a greater proportion of physics bachelors, we asked our respondents to specify how much technical training their positions required, which in turn helped us account for the wide range of reported salaries. Among the 1991 graduates who accepted employment in a service industry, a majority of them utilized their technical education which in turn corresponded to a median monthly salary of $2500. On the other hand, bachelors employed in a service industry of a non-technical nature reported a median salary of $1750. For all employers combined, **Table IX** shows no change in the median monthly salary reported by the 1991 bachelors; however, the median starting salary recorded for the service industry indicated an 11% increase. By presenting monthly rather than annual salaries in **Table IX**, we narrow the ranges paid by different types of employers. Thus, the monthly salaries paid by high schools is quite comparable to those offered by the government or industry; however, a high school teacher receives only nine or ten installments each year while industrial employees are paid those monthly salaries twelve times each year.

Since a considerably smaller proportion of women than men join the military as new physics bachelors, the overall median salary for women continues to be higher.

The tables that deal with initial employment, by definition, exclude those bachelors who did not seek employment in 1991 because they had decided to remain with the employers for whom they worked before receiving their bachelor's degrees. However, their types of employers and work activities are similar to those of the newly-employed physics bachelors, hence we present **Table X** which combines the two groups. This table relates eight work activities to the five major types of employers and indicates to what extent the graduates are using their physics training. A noteworthy change from the previous year in the distribution of work activities is the shift from research development and design to nonphysics professional work.

Table IX. Starting salaries of physics bachelors in the U.S., class of 1991.

Type of employer		Men (360 reported salaries)		Women (66 reported salaries)		Total (426 reported salaries)	
		Dist. by employer	Median monthly salary	Dist. by employer	Median monthly salary	Dist. by employer	Median monthly salary
Industry	manufacture	21%	$2530	21%	$2450	21%	$2520
	service	22	2480	18	2250	22	2400
High school*		7	2450	18	2270	9	2380
College or university		5	1580	7	**	5	1580
Government	civilian	11	2350	24	2000	13	2310
	military	33	1830	9	1830	29	1830
Nonprofit organization		1	**	3	**	1	**
Total		100%	$2080	100%	$2220	100%	$2085

**The high school salaries were calculated by dividing the annual salary by the number of months in the school year.*
***Insufficient data.*

Table X. Full-time employment* of new physics bachelors in the U.S., class of 1991.

Work activity		Type of employer: Industry manufacture	Industry service	High school	Government civilian	Government military	Coll. univ.	Nonprf. org.	Total N	Total %
Teaching		1	1	42	9	3	5	–	61	11%
Research & development		34	4	–	22	12	5	–	77	13
Development & design		39	4	–	7	3	1	–	54	9
Programming		29	31	1	10	4	4	1	80	14
Skilled labor		7	18	–	3	5	2	1	36	6
Specialized training**		2	2	–	2	84	–	–	90	16
Marketing		10	18	–	1	–	–	1	30	5
Nonphysics prof. work		18	50	–	14	20	1	4	107	19
Other		5	8	–	8	–	16	6	43	7
Total	N	145	136	43	76	131	34	13	578	
	%	25	24	7	13	23	6	2		100%
Use of physics training	Extensive	31%	11%	67%	53%	39%	66%	–		35%
	Little	53	48	30	32	46	28	50%		44
	None	16	41	3	15	15	6	50		21

**The employment of these 578 graduates includes both newly accepted positions as well as those in which graduates are continuing. Excluded are graduates in temporary, summer and foreign (N = 13) employment.*

***Training paid for by employer includes pilot/navigator training by the military.*

ASTRONOMY

Although the sizes of the two graduating classes, astronomy and physics bachelors, are vastly different we arranged their characteristics in **Tables XI** and **II** in a similar format to facilitate comparisons between them. The 140 respondents to the survey of astronomy bachelors include proportionately more women, fewer foreign graduates and a similar age distribution when compared to the physics graduates.

Table XI. Characteristics of astronomy bachelors, 1990–91.

Characteristics		Postbaccalaureate plans: Graduate study Astronomy/ Physics N	Graduate study Other N	Employment N	Undecided N	Total %
Initial interest in astronomy	Home environment	9	2	13	1	22%
	Books, TV, etc.	9	1	11	–	18
	Curiosity about nature	10	2	7	–	17
Sex	Female	11	3	15	1	21%
	Male	47	11	48	4	79
Citizenship	U.S.	58	14	63	4	99%
	Foreign	–	–	–	1	1
Age	21	7	1	6	–	10%
	22	31	9	24	2	46
	23	8	3	20	2	24
	24	2	–	4	–	4
	25 or older	10	1	9	1	16
Type of degree	Bachelor of Science	38	6	38	4	61%
	Bachelor of Arts	20	8	25	1	39
Type of bachelor's institution	PhD-granting	36	10	42	3	67%
	MS-granting	5	1	3	1	7
	BS/BA-granting	17	3	18	1	26
	Public	33	8	39	3	61%
	Private	25	6	24	2	39
Total respondents		58	14	63	5	140
Total number of astronomy bachelors		83	20	90	7	200

Table XII. Postbaccalaureate plans of selected graduating classes of astronomy bachelors, 1979 to 1991.

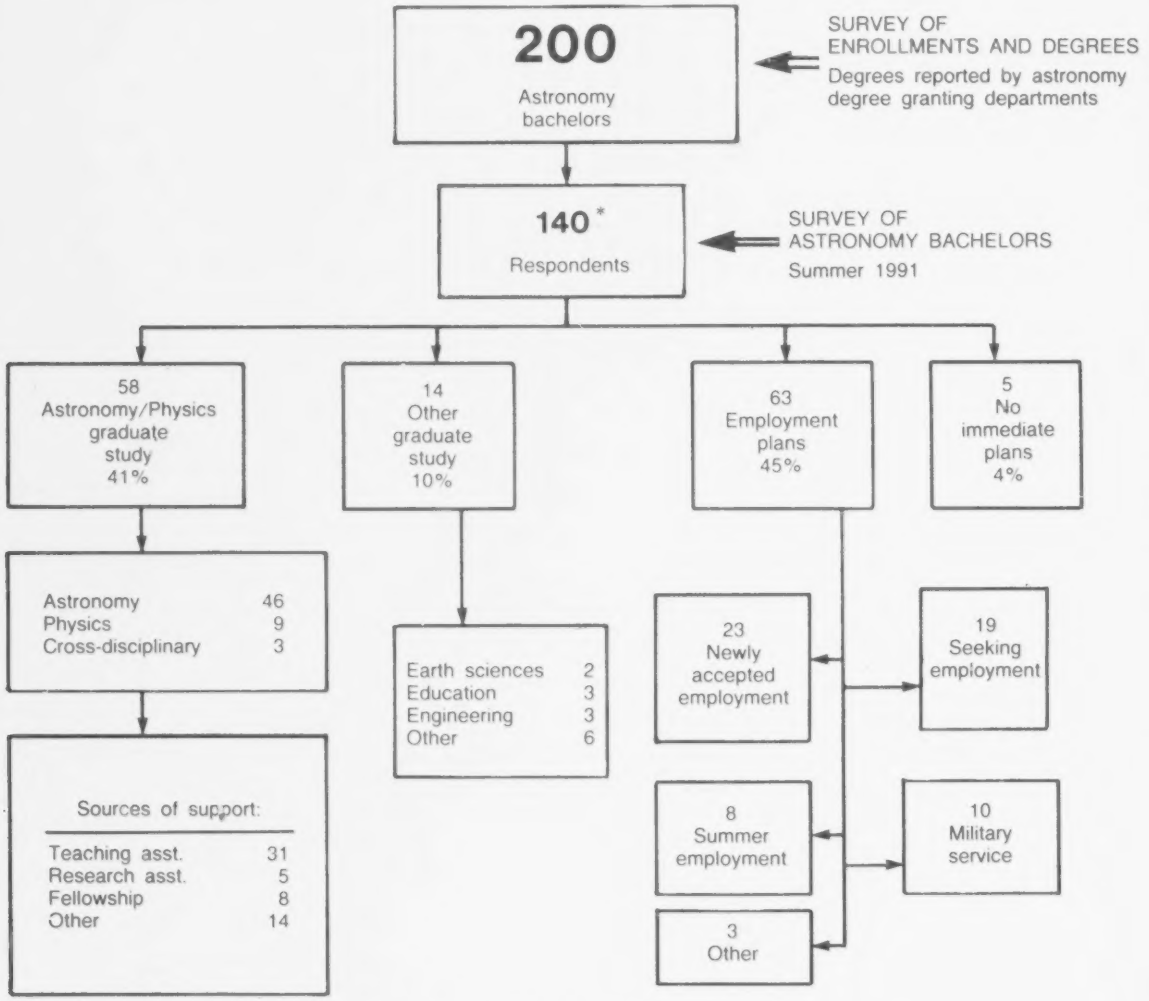
Postbaccalaureate plans	1979–80	1984–85	1989–90	1990–91
Astronomy/Physics graduate study*	42%	42%	46%	41%
Other graduate study	10	10	14	10
Employment	43	45	37	45
Undecided	5	3	3	4
Total number of astronomy bachelors	165	145	176	200

**Earlier versions of this table included physics under "Other graduate study."*

Table XII compares the postbaccalaureate plans of the class of 1991 with those of three earlier classes to show a surprising shift away from graduate study and into employment. While those plans are in contrast to the ones reported by the physics bachelors, one-third of the astronomy graduates who sought immediate employment had still been unsuccessful at securing suitable positions. These data are presented in **Figure III** along with a listing of the sources of support for the potential graduate physics or astronomy students and the areas of "other graduate study."

This report was prepared with the help of Thomas N. Stovall.

Figure III. Postbaccalaureate plans of astronomy bachelors of the class of 1991.



**Includes 24 physics bachelors from Figure II who reported a double major with astronomy.*